RESEARCH SUMMARY

Behavioural Problems After Early Life Stress: Contributions of the Hippocampus and Amygdala

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Early life stress can affect child development, with issues such as child maltreatment and poverty being linked with behavioural problems such as aggression. This type of problem behaviour can emerge after exposure to early life stress. Research has shown the link between problem behaviour and the activity of the prefrontal cortex in the brain. However, research on other areas of the brain which are involved in emotion processing and regulation, such as the hippocampus and amygdala, have not shown consistent results. Therefore, it is necessary to resolve inconsistencies in research in these areas in order to understand alterations in the neural pathways that are associated with early life stress and behavioural problems.

Past research has shown that the amygdala and hippocampus are brain regions involved in socio-emotional functioning; results from much of this research has helped lead to an understanding of the types of behavioural problems that can follow early life stress. The hippocampus is involved in memory, learning and the hormonal response to stress; the amygdala is involved in emotional and social information processing. Damage to these areas of the brain can lead to problems in the evaluation of the significance of social stimuli. There have, however, been inconsistencies in the research which has examined these structures, in both human and non-human mammals exposed to stress.

Child maltreatment, as a form of early life stress, has been shown with some consistency to result in a smaller hippocampus in adults, but even so occasional variations can still be found. Smaller hippocampi have been reported in children living in poverty, and in children who have been exposed to severe early stressors such as parental separation or loss. However, there have been no differences in the size of hippocampi found in children who were originally exposed to early neglect but later adopted into a greatly enriched environment, or in children who experienced abuse before diagnosis with post-traumatic stress disorder.

For the amygdala, however, changes in size have been inconclusive. In children exposed to early neglect research has shown larger amygdalae as well as no change in size. Adolescents who experienced child maltreatment have shown smaller amygdalae as well as no difference in size. Previous studies have often been carried out on a large age range (5-15 years), which is important because development of the amygdala is not linear. Differences in research results could also be due to methodological factors such as the way MRI is used.

This research speculated that early life stress could result in an initial increase in amygdala volume as well as increases in brain activity and alterations to the neurochemistry of the brain. Over time, this excessive functional activity could lead to a loss of neurons, which, in turn, could lead to smaller amygdala volume in individuals who are exposed to greater levels of stress or who experienced greater levels of impairments. With regards to the hippocampus, stress is thought to lead to smaller hippocampi over time.

This study looked at different forms of early life stress, such as children experiencing early neglect, physical abuse or who were from low socio-economic status (SES) households. This meant that the researchers could examine whether similar patterns of changes in volume could occur with different forms of early life stress and whether that could be a predisposition for behavioural problems. Measures of cumulative stress exposure were collected in order to examine the level to which each child was exposed during development. The study speculated that all three forms of early life stress would lead to smaller amygdalae; greater cumulative stress exposure would be associated with smaller amygdalae, and smaller amygdalae would be associated with more behavioural problems. It was also theorised that smaller amygdalae would partly account for the contribution of cumulative stress exposure to individual differences in behavioural problems. The same hypotheses were applied to the hippocampus.

The research showed, with images gathered from MRI scans, that each form of early life stress was indeed associated with differences in the amygdala, with each group studied having smaller amygdalae. The volume of the hippocampus was also smaller for children exposed to physical abuse and children from low SES households compared to children in the control group. For the amygdala, the results for early neglect were in contrast to results from other studies which had shown either no difference or larger amygdalae, whilst for physical abuse the results were similar to other studies. Results for tests on the hippocampus were similar to those in the existing literature. Uniquely, it was also discovered that greater cumulative stress exposure was associated with smaller volumes for the amygdala as well as the hippocampus. These smaller volumes in both structures are associated with behavioural problems.

The researchers note that their sample size was larger and had a broader age range than previous studies, therefore the range of early life stress could be higher in this study. They caution that only longitudinal studies can validate to what degree amygdala development is affected by such stressors. However, this study helps to enhance understanding of the structural and functional alterations that can take place in both the amygdala and the hippocampus as a consequence of exposure to different forms of early life stress. In addition, further insights are gained into the individual differences in the risks of, and resilience to, behavioural problems that are seen after a child has experienced very stressful situations in the early years.

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